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MONANTHA VETCH

(Vicia monantha)

*A Valuable Cover Crop for Fruit Land
in California*

THE CULTURE OF MONANTHA VETCH AND ITS USES

By A. F. ETTER

"It is my belief that in the cover crop we have the fundamental key to soil improvement." — Dr. H. J. Webber, Director California Agricultural Experiment Station.

Albert F. Etter
ETTERSBURG, CAL.
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FOREWORD

WE HOLD THE SOIL IN TRUST

It has been stated—and rightly so—that the economic future lies with intensive farming and fruit growing. Every year the ratio of cultivable land to the increasing population shrinks. In the East we are confronted with large numbers of abandoned farms, primarily due, it is explained, to extraordinary, high wages attendant upon the late war, but even now these same farms are not being rehabilitated to that degree that would allay alarm in this direction. However, it is not so much with the question of abandoned farms that we in California are concerned, as with the proper maintenance of farms that are not abandoned.

In an effort to market a given fruit or vegetable ten days in advance of a previous season, or to eclipse all previous records of production, we are likely to lose sight of an all-important duty—that of the proper conservation and maintenance of the soil itself.

We could point out certain of the Eastern states, wherein this matter of soil conservation has not been followed, and the result may be seen in the statistical reports issued from year to year. Certain states accounted wealthy may only lay anonymous claim to this distinction if their depleted agriculture is considered, for they not only do not produce sufficient fruits, vegetables, meat or dairy products to sustain their own population but are compelled to import such commodities from neighboring states.

True, they are wealthy, as wealth is accounted, but today they are simply trading their coal, timber, iron and manufactured products for the life-sustaining agricultural essentials that they should—but do not—produce. Under such conditions, when the time arrives, as it will in the comparatively near future, when these valuable natural resources of coal, oils and metals are finally exhausted, then a return to the soil as the only relief will be mandatory, and then too with the added burden of an ever-increasing population, the penalty of soil-neglect will be appreciable to a greater degree.

We are rapidly approaching a period wherein the combined efforts for improvement along all lines of agricultural endeavor will be reflected in our economic well-being and inversely any inopportune neglect will be visited upon us as a manifold penalty.—G. H. Hecke, Monthly Bulletin, Department of Agriculture, State of California, May-June, 1922.

MONANTHA VETCH

(*Vicia Monanthos*)

By DR. P. B. KENNEDY, *University of California*

All countries sooner or later find it necessary to supply green manure to the soil. Long ago the agriculturist in India found it necessary to supplement his supply of farmyard manure. His method was to gather the leaves and twigs from the forest, going to the trouble of carting them even ten or fifteen miles to his farm. Blindly he followed this method of utilizing any kind of leaves until by experience he observed that certain kinds of trees produced leaves that when incorporated with the soil increased the yield of his crops. He attaches such a high value to the leaf manure that he is willing to pay owners of forest lands a fee for the right of collection.

In Java they use a tree legume which they grow with each coffee bush for the shade and supplying nitrogen from the nodules on the roots. Similar instances are found in every country.

In the United States it has been found that a continued application of mineral fertilizers brings about a bad physical condition accompanied by poor drainage, poor aeration, and frequently alkali troubles. The plowing under of green manuring legumes seems to be the only safe method in maintaining the fertility of the soil with only occasional applications of well selected mineral fertilizers for special conditions of soil or crops.

The diversity of the climate and conditions in California necessitate that we must have a large choice in the varieties used for green manure; some suitable for winter growth, others for summer. We must have those that may be grown under irrigation and with the natural rainfall.

The following articles by Mr. P. A. Ingvason and Mr. Albert F. Etter relate their experiences with a promising legume, the one-flowered vetch or lentil, ***Vicia monanthos***. The records of the University of California show that this vetch was grown at the Central Station at Berkeley, the Foothill Station at Jackson, Amador County, and the Southern California Station at Chino Valley, from 1900 to 1905. It was at that time considered promising and recommended for further trial. The experiments with legumes were discontinued until 1914 when the writer took up the study of all legumes promising for green manure or forage.

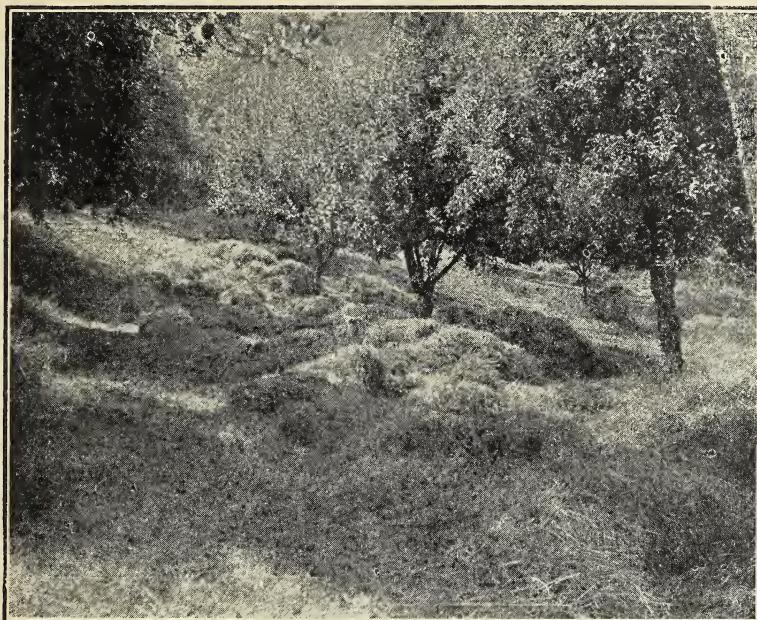
Our experiments and observations indicate that it will find a definite place as a forage, either as hay or for the good value of its seed, as well as for green-manuring purposes. A yield of ten tons or more per acre may be expected. In addition the roots would supply about three tons per acre.

Experience With Monantha Vetch In Central California

By P. A. INGVASON, Consulting Agronomist, Fresno, California

During the past three years the writer has conducted quite extensive cultural tests with Monantha Vetch in the coastal as well as in the interior counties of Central California. There trials have proved the absolute merit of Monantha as a cover crop for orchards and vineyards, and in the coastal region the vetch has done nicely on grain lands and in non-irrigated orchards.

Although the tonnage of green manure produced by Monantha does not equal that produced by certain other vetches when planted



Monantha Vetch in a hillside orchard. The crop is being harvested for seed. Subsequently the haulm is spread and plowed under.

under favorable conditions of soil, temperature and moisture, yet the superiority of Monantha over and above most other species can be recognized under average field conditions as those obtain in Central California where precipitation is irregular and the soils have lost their humus content as well as retentiveness for moisture. Under such circumstances Monantha represents itself as a crop plant and a manurial asset of tremendous value and great significance to husbandry in general.

The writer would especially recommend to the fruit growers of the Santa Clara and the San Joaquin Valleys the utilization of Monantha

as a winter growing cover crop which under irrigated conditions should be allowed to mature and form a mulch on the ground, thus reducing soil temperatures 15 degrees to 20 degrees Fahrenheit and at the same time controlling the growth of weeds.

Where such practice is employed the orchard or vineyard must be laid out for irrigation during the autumn before seeding takes place. Seeding should be done with a press drill at the rate of 25 to 35 pounds per acre. On light sandy ground a dressing of from 100 to 150 pounds of superphosphate to the acre should be given at the time of seeding or preferably a short time previous. On light, open, half sterile soils a small dressing of rotted cow dung or sheep manure will prove a suitable fertilizer and stimulant to the symbiotic nitrogen-fixing bacteria which work on the plant roots.

Provided that seed of Monantha is allowed to ripen and fall on the ground, the crop grows spontaneously the next year wherever proper methods of handling the soil are being employed.

Monantha has come into Central California to stay; to be recognized in its proper place as one of the most valuable among the legumes. Just now, as this is being written, several large orchard and vineyard interests in the interior valley are preparing to sow Monantha.

Mr. A. E. Etter deserves great credit for his painstaking work and perseverance in pioneering the field of Monantha culture in California. The fundamental principles of its field culture as explained by him in his treatise which follows, the writer can testify would apply generally in Central California.

Monantha Vetch (*Vicia monanthos*), Its Culture, Uses and Prospects In California's Agriculture

By ALBERT F. ETTER, Ettersburg, Humboldt County, California.

VICIA MONANTHOS—

This formidable big botanical designation translated into everyday English means literally, "one-flowered vetch." In habit it has a single blossom on a flower stem where other vetches have from two or three to as many as fifty.

HISTORY—

As for the writer, all he knows of the history of the introduction of this valuable plant into this country is that it has been grown at Ettersburg for the past eighteen years, and all the while growing more in favor. This original seed was secured from the Department of Agriculture at Washington and from the University of California, both lots being secured the same season, in 1905. Inquiry at Washington traced the importation to the French seed house of Vil-morin, Andrieux & Company of Paris. From the nature of the plant, I would say it is a native of Northern Africa or Asia Minor, as it is evidently at home in a hot, dry country similar to the climate of California. It is characteristically a winter grower and summer rains are its worst enemy.

CULTURE—

By years of observation here at Ettersburg, I find the ideal time to sow this legume is before the fall rains, which in this locality usually occur between September 15th and October 10th. Germination at this time seems to give it an advantage over later sowing. Possibly this is closer to nature, but it seems that even on the same ground the dry sown will always look a little better than a later sown. If but a light rain comes and sprouts the seed with not enough moisture to penetrate deep, this vetch will stand a drought that seems almost impossible for any plant to weather.

In regard to preparation of the seedbed, *Monantha* seems about as nearly able to take care of itself as any cultivated crop I know of. I have seen splendid crops volunteer here from seed scattered by the preceding crop, and just as good on the same land where untouched as where it was harrowed in on land adjoining. Indeed one who did not know could not define the line between the two. I believe on land not yet inoculated, one stands a better chance of getting it started on land not freshly plowed than on newly prepared land. In my estimation, the ideal seedbed to start it is a summer fallow or summer cultivated, as in an orchard. Where a scant crop has been grown on land by winter or spring seeding, a very heavy crop will follow volunteer, or simply by harrowing it in. Judging by our experience here, one rarely gets a good crop the first time it is sown on land. But this year we got a fair crop on orchard land that had not been plowed for four years, and which at the time it was spring-toothed in, carried a heavy stand of broncho grass. I think, had this been harrowed in dry, it would have made a heavy crop. The ease of its culture, following crop after crop with the minimum of cultivation makes it a particularly attractive crop. This observation applies to our conditions in this region where the soil is naturally not inclined to run together and bake hard. On heavier lands experimentation alone must work out the most favorable methods of preparation.

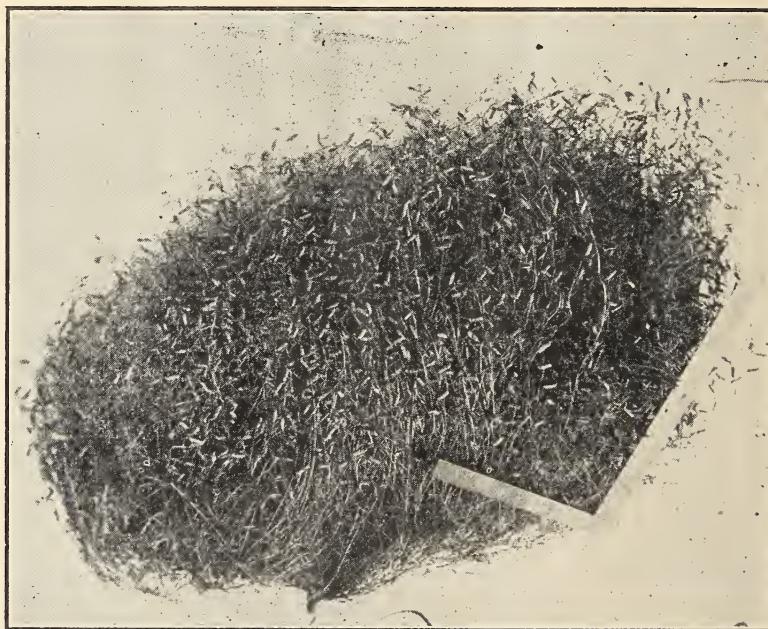
INOCULATION—

Like all legumes, *Monantha* vetch succeeds best only when inoculated with the bacteria so it can draw nitrogen from the air. It seems most capable of getting a plentiful supply of these nitrifying bacteria started on its roots when the soil is well supplied with moisture and the weather cool, as in the late fall and early winter. Since warmth of the soil as well as moisture and adequate time are necessary, the earlier plants get started in the fall, the more opportunity they have to secure perfect inoculation.

One, and only one disadvantage, I have noted by too early a start in the fall: The ground may become so densely covered—if the growth reaches a height of six inches—that in a warm rainy spell with little or no sunshine for a week or two, the whole mass of succulent growth develops a damp-off, mould or mildew and leaves the ground almost bare. Where goats or sheep can be run, this can readily be remedied by grazing and holding the plants short. This grazing has no ill effect as far as I have noticed. Any tramping of the soil seems to do no injury to the plants. Indeed, in the orchard where apples were hauled out when the ground was quite wet, seemed to grow just as good a

crop as alongside the wheel tracks, and if anything, produced heavier seed yield.

We have also learned that to get a heavy seed crop, grazing in the spring is necessary to hold the plants back so they do not cover the ground too early and all run to straw. If the plants get to making a rank growth early in the season, and since they will not blossom before



Monantha plant grown from a single seed. Note the luxuriant growth and prolific bearing of seed.

the regular time in April anyway, they get to vining and may attain a length of five or six feet. With the dense growth, the soil always remains wet and little seed is produced. In this condition also, a heavy rain, or any rain sufficient to make the whole mass sodding wet, may mean the ruin of the whole crop so far as seed is concerned. The whole mass will be as wet as if soaked in the river, and begin to damp-off and mould, and die at the root. Even in this condition, it will make fair hay but the seed prospect is ruined. The best prospect for heavy seed yield is when the plants stand erect and begin flowering when about sixteen or eighteen inches high.

Since inoculation is necessary and we know fairly well the conditions that favor it, it is obvious that an open warm soil favors it, and the heavier and colder the soil is the less favorable it is to secure inoculation. We have secured good inoculation by using the commercial cultures, and also by wetting the seed and stirring enough well inoculated soil in with the seed to thoroughly coat it with the soil mud; and then sow before it has become dried off again. If one wishes to determine positively if a certain soil will grow Monantha vetch, I know of no more certain method than by sowing a short row and directly on

the open drill, sow a quantity of inoculated soil from a field where the soil is known to be well inoculated. This may seem extra work, but it is nevertheless, a fact that if you are positive it will grow you will find a way to get positive results because you know they are obtainable. On the other hand, if your test has failed, you may make another inexpensive test and not waste valuable time, land and seed and get nothing.

NATURE OF MONANTHA VETCH—

When germinating, Monantha vetch throws up a single stem which later begins to branch at the ground, and a single plant may produce from one to two hundred stems if off to itself and under ideal conditions. While 25 to 50 pounds are usually recommended to sow an acre, I am positive I have seen stands that did not represent five pounds per acre, densely cover the ground and produce a good crop. It is not the amount of seed sown, but the amount that actually gets through to make a growth that counts in the final crop.

The early growth is fine, tender, short jointed and quite different from the spring growth. As soon as the first growing weather arrives, the Monantha begins to make active growth. It not only grows at a lower temperature than almost any other legume, but it grows much more rapidly. Last spring when the native clovers had reached a height of two inches, the Monantha vetch was six to eight inches high. And at this early date it had made twice the growth of the Winter or Sand vetch.

Before the rank spring growth begins Monantha is perfectly hardy against frosts as low as we ever get them at Ettersburg, that is, down to about 15 degrees. Heavy frosts after it has attained a growth of a foot or more, have not materially injured it outside of laying it flat to the ground. After blossoms appear, along in April, it is much more tender and susceptible to injury by frost, being in this respect like common peas—the frost killing both the blossoms and the young pods. Summing up, I might say: If garden peas in your locality are not injured by frosts when in blossom and pod, Monantha vetch is comparatively safe too.

Monantha being sown in the fall is not interfered with by any summer weeds that injure spring grown crops. Land so foul with Redroot, Lambsquarter and Tumbleweed that a spring crop is almost impossible, need never give the slightest concern to a crop of Monantha vetch. Morning glory and Johnson grass might make some growth, but I doubt if it would amount to much.

MONANTHA VETCH AS A COVER CROP—

In our orchards here we used to get a fairly good growth of native clover, alfilaria and grass to turn under each spring. Gradually and surely, it grew less and less. This is the experience of many an orchardist. In such a situation we experienced some difficulty in getting Monantha vetch to start. Now where we have it well started, we get a heavy growth on the land, let it ripen, harvest it, and harrow in another crop and the trees are doing better than they used to do with summer cultivation. Always there is a heavy crop of leaves fall from the ripened vetch, and then the stubble and general nitrogen gathering power of the plant seem to be quite sufficient.

The Monantha vetch plays a self-helping part while it occupies the land. It gathers its own nitrogen from the air through the nodules on the roots. These nodules, to develop readily, must have a reasonable supply of moisture. Soil well bacterialized is "alive" and holds moisture where "dead" soil rapidly parts from all its moisture. Monantha vetch by its habits of forming a dense growth on the ground, naturally protects the surface from drying winds, and I am quite sure, where the dews are very heavy, it actually adds to the moisture on the surface rather than taking from it. When plowed under when about a foot high last spring, it entirely rotted away in about ten days so that when again plowed, little or none was noticeable.

Another valuable feature of it as a cover crop in an orchard, is its ability to grow well under the trees, even dense trees like the apple and walnut. It not only makes a good growth of forage under the trees, but has even produced abundant seed there in the shade. This latter shows that the nitrogen gathering faculty functions properly even under the trees in the shade.

AS A FORAGE CROP—

Monantha vetch is a many sided utility crop. When cut green for hay it is probably more nutritious than alfalfa, making most excellent hay for cattle, sheep and goats, but it is rather too laxative to feed much of it to horses. However, it does not appear to be laxative to other stock.

When left to ripen it still makes most excellent forage. Fed to milk goats, supplemented with the same pasture feed, they gave more milk on a ration of Monantha vetch than they gave with one quart of "Moluso" meal per day. This was not the well seeded ripe stock, but that which had made a rank growth and had not filled to make it worth while to thresh. Judging by the way jackrabbits take to the ripe straw and seed in the pod, it would seem it should make a great rabbit feed. Poultry also eat it well when young and tender.

When the seed is threshed out, the straw and chaff still make very good feed and it is eaten up slick and clean. Sheep turned onto the stubble field will eat the ground bare of stubble and leaves. It makes a good pasture if left to develop pretty well to maturity before stock are turned in. Sheep turned in on a full ripe crop would beyond doubt harvest it completely. The seed is very nutritious, being very high in protein.

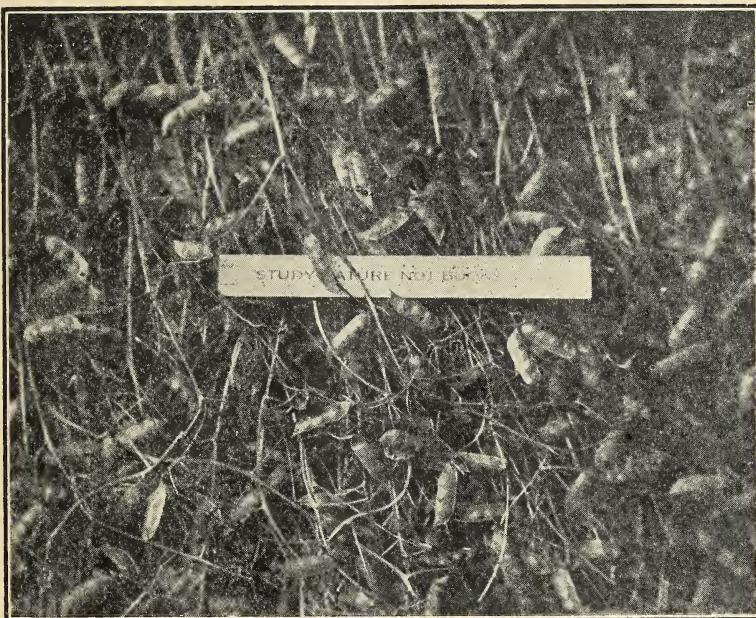
The yield of dry forage per acre will run from one to four tons. Where it takes hold in earnest and grown four or five feet high, one can hardly find room to pile it up when cut, there is such a bulk of it.

Formerly we sowed the grain with Monantha vetch to prevent it from falling, but where it really was necessary, the vetch grew over the grain and smothered it, and the grain made very little growth. There is always a chance, but I think it is easier to control by pasturing than by the addition of grain.

MONANTHA AS A SEED CROP—

Monantha vetch as a seed crop is easily handled. It can be cut immediately after the pods begin to ripen, or it may be left for weeks in the field without any great loss of seed by shattering. A tempera-

ture of 95 to 100 degrees for two weeks just after the crop had ripened, shattered very little of it. It will easily make half a ton of seed per acre, and I have no doubt that under very favorable conditions, on fairly heavy land, it would be possible to get two tons of seed per acre, though half that would be a good crop. The crop is cut with a mowing machine supplemented by the spring pea guards, and side delivery winnower, both of which are to be found described in Sears-Roebuck catalog. These two additions to a mowing machine are almost as essential as the mower itself in harvesting *Monantha* vetch for seed. After cutting it is shocked up, later to be stacked and threshed by machine or tramped out by horses. The machine cracks a good many if they are very dry and hard. If they are not quite dry, they are too tough to thresh and run through without threshing as a good many of the teeth must be taken out or the machine will grind the seed to meal. Threshing by horses is fas enough, but there is the fanning up to do to



A field of *Monantha* Vetch ripe unto harvest. In this close view note the slender stems and plump seed pods

separate the seed and chaff. But one gets no broken seeds by this processs. Probably a bean thresher would be all right and work perfectly.

THE SEED AND ITS USES—

If one wishes to use this highly desirable seed as a human food, the first thing to do is to call it a lentil, since nobody cares to eat a vetch. Once we call it a lentil, it will be found quite or nearly as acceptable in soups or porridge as the true lentil. It can be milled with wheat and then makes a good combination with 75% wheat flour for a form

of bread. While this bread is dark, it is also more nutritious than wheat bread, since Monantha lentils are about 35% protein. It also makes a most acceptable breakfast mush when mixed with wheat. Ground into a flour and cooked and then baked with strips of bacon laid on top, it makes a dish fit for a king—equal to any baked beans.

SUMMING UP—

By the foregoing I have written, it should be apparent to anyone, that Monantha vetch is likely to become one of the staple crops of California. It is a many-sided utility crop—a long felt want, especially for a crop to renovate worn-out wheat land. It is an ideal cover crop for orchards. In the San Joaquin Valley it gives promise of being one among the best cover crops ever tried out.

It is a heavy seed producer and is of a nature unlike other vetch, it can be harvested without any great loss. It is a great stock food in any way stock forage can be used. It is easily harvested with ordinary farm tools. While green it may be hard to cut it for hay with an ordinary mowing machine, but even so, if you can get only a part of it, as soon as the stubble dries, the hay rake will gather it all clean from the ground. Indeed, one could almost harvest the ripe crop with a hay rake alone.

Since the seed could be produced in abundance, it would seem it should be grown and marketed at the price of wheat, thus being a boon to the orchard and vineyard interests who need cover crops. It requires the minimum of cultivation, even to volunteering itself year after year on favorable land. The seed is a splendid addition to our cheap and nutritious human foods, and also makes an ideal stock food, making a rich meal which might serve as proteids for feeding dairy cattle. It is a good chicken feed, but may require some time to teach them to eat the seed.

In this treatise on Monantha I have stated plain facts but still I have left much unsaid. However, I trust it is the best write-up *Vicia Monantha* has had on this side of the Atlantic, and by one with long experience in its cultivation. I have seen much of California, and I am quite certain that Monantha is going to be a winner.

FIELD NOTES ON MONANTHA IN THE SAN JOAQUIN VALLEY—

For the past three years Mr. A. R. McGuire, who is an engineer by profession, has been the manager of 5,000 acre irrigated farm in the Mendota district of Fresno County.

His extensive and varied experience qualifies him to speak authoritatively on cover crop practice in his own vineyard to which the following letter refers.

(Copy)

Giffen Ranch, Mendota, California,
May 5, 1923

Mr. P. A. Ingvasion,
2146 Merced Street, Fresno, California,

Dear Sir :

Replying to your inquiry about Monantha vetch which you recommended for use as cover crop in my vineyard, I submit the following facts :

During the early part of December of last year I sowed this particular vetch together with *Melilotus alba* into the dry soil of 90 acres of my Muscat vineyard which is situated seven miles southwest of Mendota, in Fresno County. Seeding was done with a specially constructed combination (triple hopper) drill at the rate of 11 lbs. per acre of vetch and 2 lbs. of *Melilotus alba*.

Despite irregular and very scant seasonal rainfall, which amounted to only 3 inches, I secured an excellent stand of cover crop. The vetch sprouted and struck root in soil which was barely damp to the touch. During the cold spells the vetch turned brownish but still grew and thrived, shielding the rather tender seedlings of *M. alba*.

During seven weeks of drought extending from the early part in February to the end of March, I irrigated the vineyard by light flooding. The vetch grew apace throughout the entire droughty period, making, so to say, a dense and fine textured carpet of vegetation over the entire ninety acres of vineyard.

In due season I disced under this green manure crop but still left the clover roots alive in order to allow them to penetrate deep into the rather heavy subsoil thus opening the ground to air and moisture and enriching it in humus throughout.

In point of economy in the use of irrigation water and saving on tillage operations, I consider a good crop of green manure a great factor. Beyond shadow of doubt cover crops constitute the most inexpensive yet most effective means for conserving soil fertility thereby enabling us to produce fruit of good standard grade and high quality. It is my candid opinion that leguminous cover crops properly selected and correctly applied form the sheet anchor of the grape growing industry now during these tempestuous times of economic disturbance through which our State is passing.

Yours faithfully,

(Signed) A. R. McGuire.

Messrs. Wilson and Cauble of the Kerman district, Fresno County, have utilized *Monantha* as cover crop for very light half sterile soils both singly and in an admixture of other hardy vetches such as *V. dasycarpa*. The results were in every case eminently satisfactory. For the last two winters *Monantha* has grown spontaneously in Mr. Cauble's apricot orchard where it was sown three years ago.

Inoculation of Legumes

By DR. F. E. TWINING, Soil Chemist, Fresno, California

If a legume—for example, alfalfa, clover, beans, or any member of this family of plants—is dug up carefully and the roots washed and examined, a number of plump swellings, or nodules may be seen on the roots.

If a portion of the inside of a nodule is examined under the microscope, numerous rod-like bodies may be seen. These are the nitrogen-fixing bacteria (fixing because they take the free nitrogen from the air and fit it in the plant) which are far too small to be visible to the naked eye. Each nodule contains millions of these nitrogen fixing

bacteria. Here in the nodule the bacteria feed upon the plant juice and, in return, furnish the plant with nitrogen. The bacteria use nitrogen from the air and combine it in a form suitable for the plant. It is the custom to speak of these small organisms as the co-operative bacteria; that is, the plant and bacteria live together, each working to help the other. This association of plant and bacteria is not absolutely necessary for the growth of either the plant or the bacteria, but it is beneficial to both. When grown without bacteria, the legumes feed on the supply of combined nitrogen in the soil, just as do the non-legumes, corn, wheat, oats and other crops. The presence of these bacteria within the nodule brings about the chief difference between the feeding power of legumes and cereals. Due to the activity of the bacteria, the leguminous plant obtains a large portion of its nitrogen from the supply of free or uncombined nitrogen in the air. Because of this property, the legumes are particularly valuable for food and fertilizer.

The life history of these minute soil bacteria makes a fascinating story. The nodule bacteria may live in the soil without the plant; for how long is not known. However, when bacteria come in contact with a legume root, they enter it and grow rapidly. In young seedlings it takes only a few hours for the organisms to enter the fine root hairs. Here the bacteria find a suitable home, multiply rapidly, and soon push out the covering of the root and form what are known as tubercles or nodules. As the plant grows, the bacteria multiply, the nodules increase in size and number, and the nitrogen of the air taken by the bacteria is combined in such a way that the plant is able to use it for food. About the time the legume begins to form seed the nodules cease to grow, lose their plump appearance, begin to shrink, and eventually decay, and the bacteria are returned again to the soil. Here the bacteria remain for a considerable time, ready to enter another legume and repeat their life cycle.

If the nodules are absent from the roots of a legume, the proper bacteria should be supplied before this legume is planted again. The distributing of the legume bacteria so that they may come in contact with the roots of the legume, enter the roots, and form nodules, is commonly called inoculation. Experience has shown that nodules may not form on all the legumes in different soils. Generally, the failure to form nodules is due to the absence of the legume bacteria. And when legume seeds are planted they should be inoculated with pure cultures before planting.

The distribution of the bacteria in pure cultures may be carried out in several ways. Generally the pure culture is shaken up with water and the mixture is then sprinkled over the seeds, which are stirred until each seed is moistened. By this method the bacteria are brought in contact with the seeds and are carried with them into the soil. When the seeds germinate and form small roots, some of the bacteria come in contact with these roots, gain an entrance, and form nodules.

Legumes offer the best known means of maintaining soil fertility and rejuvenating over cropped and worn out fields. They add both humus and nitrogen to your soil and thus increase the yield of other crops.



